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I.—GROUND-NUT, OR PEA-NUT.

(*Arachis hypogæa* Linn.)

Arachis hypogæa is a plant unknown in the wild state. There is no knowledge to be recorded of its early history. How it came into cultivation cannot now be traced. That America gave the race birth is beyond doubt, and it is clear that in the sixteenth century Africa and Asia received it. Since then it has spread, so that the area of its extension is now over the whole of the tropics, and into a large part of the temperate regions suited to the vine. Wherever grown its richly oily seeds serve as a food, and during the last 60 years it has obtained a wide use in Europe as an oil-seed.

Many small controversies have arisen over *Arachis*, and many misunderstandings of the plant. The origin of the plant, the sexes of its flowers, the nodules of the root, have been among the causes. The calyx-tube has been a fruitful source of mistake, and the origin of the name *Arachis* is hopelessly obscure.

Description.

The genus *Arachis* is a peculiar one of the large order *Leguminosæ*, in which it belongs to the sub-order *Papilionaceæ*. All the known wild species of *Arachis* inhabit Tropical South America, and doubtless the largest member of the genus, *A. hypogæa*, was worked up by the cultivation of centuries in the home of the race. It is a clover-like plant; indeed, a field of it forcibly suggests a luxuriant crop of clover. The stems may attain a height of 1 to 2 feet, or at times of 3 feet, but for the most part lie more or less prostrate on the soil. It is the custom in the United States to plant the rows 2½ to 3 feet apart, when the branches ultimately meeting have a length of nearly 2 feet.

The leaf of *Arachis* has four leaflets placed in pairs, each attached by a motile organ (pulvinulus) to the common leaf-stalk; like clover leaflets they exhibit sleep movements, each pair folding together at nightfall and remaining thus until dawn.

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The flowers, which are pea-like and bright orange-yellow, are produced one at a time from large buds at the bases of the leaves. Their duration is but short, for they wither for the most part on the day of their production.

Outside the orange-yellow petals is the yellow-green calyx, rather irregularly divided into the five sepals, and below it the long calyx-tube (at times $\frac{3}{4}$ inch long), which to the eye appears to be a footstalk to the flower. At this period the flower has no peduncle, and the ovary lies within the calyx-tube protected by the bracts in the leaf-axil. It is only after the fertilisation of the flower that the true peduncle appears.

Not all the flowers fruit; many never advance beyond the blossoming stage, and have been thought to be male flowers. After fertilisation, as the first preparation towards fruit-ripening, the petals and sepals shrivel, while the calyx-tube is cut off by a ring at the very base. At this time the true peduncle begins to grow, and turns downwards towards the earth, carrying the remains of calyx and corolla as a cap and appendage over the small ovary. Not until the earth is reached does the swelling of the fruit commence; then the cap just mentioned falls off, the scar which is left by the separation of the style at its base becomes exposed, and the young pod, at first sharp at the end, commences to penetrate the soil. At 1 to 3 inches below the surface, rarely deeper, it ripens in the course of a few weeks into the familiar "earth-nut." The usual number of seeds in a pod is two; one is not uncommon, three rare, and four to five occur only in a form which, according to Heuzé (*Plantes industrielles*, ii. p. 135) is found in Costa Rica.

Any flower whose ovary fails to reach the ground fails likewise to produce fruit. Correa de Mello (*Journ. Linn. Soc.* xi., p. 254) records an experiment in which he prevented the flower-stalk from penetrating the earth by interposing an object; in the attempt to round the obstacle the peduncle grew to 4 or 5 inches long, but failed, and the immature ovary died without enlarging. Fruiting is thus dependent on the effectual burying of the young pod. It is obvious that the flowers of the upper part of the stem stand in a disadvantageous position, for they can less readily bury their pods, nor do many of them appear to make the attempt. When harvest comes the plants may be raised from the ground and stacked to dry in the fields, the nuts hanging on to their stalks among the roots; then will be seen on the root-fibres little nodules which are transformed rootlets, altered in internal structure, and of a peculiar use to the plant. Such tubercles are common in the *Leguminosæ*, and by possessing the capability of absorbing free atmospheric nitrogen enable the plant to gain this necessary food in a way not open to other orders of the higher plants. They are indicated in many figures of *Arachis*.

It has been said (Eriksson, *Studier öfver Leguminosernes rotknölar*, Lund, 1874) that *Arachis* lacks these tubercles; such is not the case. Several observers have mentioned their existence, notably Lecompte (*Comptes Rendus Acad. Paris*, 119, p. 302), and specimens from many parts of the world preserved at Kew may be seen to possess them. That they are formed less readily in some soils than in others is stated by Andouard (*Comptes Rendus Acad. Paris*, 117, p. 298), and may well be the case.

Races in Cultivation.

The many different forms of *Arachis hypogœa* which exist, admit of a rough classification into "bunched" and "running" varieties. In the one the stems are erect, in the other prostrate, but ascending at the tips.

Botanists have seized on this difference as a means of classifying the forms, and have applied the names—inappropriate to an American plant—of *africana* and *indica*. The former name embraces the running, the latter the bunched forms.*

Typical among running forms is that commonly grown in Virginia; its spreading branches may have a length of two feet, or even more, and pods are borne on them almost to the tip. The "Spanish" pea-nut" is an extreme of the other type, with several erect stems and the pods crowded at the base—a condition imposed on the plant by the impossibility of thrusting nuts from upper flowers into the soil.

Between these two extremes fall the many forms dispersed over the world; we possess but little information leading to a determination of their relative merits.

Upwards of three quarters of the nuts grown in the United States are sold in the streets for eating. Those most in demand are the Virginian, on account of the relatively small percentage of oil which they contain. Virginia produces two forms; one, as described, "running," the other "bunched." The pods of both kinds are large and white.

Tennessee grows two forms—"white" and "red," so-called from the colour of the seed-coats. The former is a running variety closely resembling the Virginian form; the latter, with seeds less agreeable to the taste, is more or less erect in habit, and favoured as a forage crop.

North Carolina grows a form resembling the African plant in habit, with heavier and smaller pods than those of Virginia; and Georgia produces a red-seeded form, bunched, and with three or four seeds to the pods.

The so-called "Spanish pea-nut," grown in the United States, is a bunched form, alike in favour for forage and for confectioners' purposes on account of the sweetness of its seeds.

Costa Rica produces the form named earlier, whose abnormally long pods contain four or five seeds; in the Argentine one with orange-yellow husks is common.

African forms, despite the application of the name *africana* to the bunched group, are for the most part semi-prostrate. On the Senegambia coast two forms exist, taking their names from the place names of Galam and Cayor. The Galam nut is that which chiefly supplies the exports of West Africa. Rufisque has been

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**Arachis hypogœa* var. *africana*, F. Kurtz in Verhandl. bot. Vereins Brandenburg, 1875, p. 45 is *A. asiatica*, Lour. Flora Cochinch. p. 430, and the "Arachide d'Afrique" of Cordemoy in Adansonia vi., 1866, p. 249; while *A. hypogœa*, var. *indica*, F. Kurtz is *A. africana*, Lour., the "Arachide de l'Inde" of Cordemoy.

De Candolle's var. *glabra* (Prodromus ii., 1825, p. 474) is a hairless form; Hasskarl's var. *aegyptiaca* (Retzia i., 1855, p. 190) is a prostrate form which he thought perennial; Harz's varieties *reticulata* and *vulgaris* (Samenkunde ii. 1885, p. 643) are defined on the conspicuous or obscure reticulation of the pod; we need not concern ourselves further with them.

the chief port of shipment; thence the British Colonies of Gambia and Sierra Leone obtained seed, and practically throughout these dependencies this is the form cultivated. The Cayor nut from Senegambia is coarser, thicker-husked, and yields an inferior oil.

Egypt produces a very prostrate form.

On the Mozambique coast a rather small-podded plant is cultivated (W. W. A. Fitzgerald, *Travels*, London, 1898, p. 259).

Very little information is to hand concerning the varieties met with in Asia. Like the African, the Indian plant is semi-prostrate. Two forms, differing in the colour of the seed, are grown in the Malay Peninsula and in Java; two forms are reported from Trincomalee in Ceylon (*Trop. Agriculturist*, iii., p. 567), two have been introduced into Queensland and North Australia, and two exist in Japan.

Handy (*U.S. Dept. Agric. Farmers' Bulletin*, No. 25, 1896, p. 5) has gathered together the following analyses which place Japanese nuts as richest in oil, in the next rank those from the tropics of the Old World, and those from North America last. His analysis of Alabama nuts is vitiated by an obvious miscalculation, and we omit it.

Origin.	Water.	Percentage in dry substance.				
		Oil.	Proteids.	Soluble non-nitrogenous matter.	Fibre.	Ash.
Japanese :						
"Tojin-mame"	7·50	54·60	26·49	12·64	4·32	1·95
"Nankin-mame" ...	15·61	54·54	32·66	5·99	4·88	1·93
Tropics of Old World:						
Congo	5·01	52·88	28·33	14·51	1·55	2·73
Rufisque	4·59	52·48	29·73	14·02	1·24	2·53
Egyptian	—	52·30	22·97	20·27	1·61	2·85
Bombay	7·71	50·47	33·73	10·15	2·33	3·32
Southern United States :						
Tennessee (1888 crop) ...	3·87	49·35	28·65	17·23	2·37	2·40
„ (1889 crop) ...	4·86	48·60	27·07	19·30	2·52	2·51
Georgia	12·85	43·13	30·49	21·86	2·34	2·18
"Spanish," grown in Georgia	13·15	41·17	32·18	20·43	3·50	2·72

Other analyses may be found in Church, *Food Grains of India*, p. 127, Schädler, *Technologie der Fette u. Ole*, and in the *Journal de Pharmacie, Chim.*, sec. 4, xviii., p. 14. Heuzé (*Les plantes industrielles*, Paris, ii., p. 139) places the yield of oil of Spanish grown nuts at 60 per cent.; we are unaware of the authority whence he drew the statement, but believe the amount exaggerated.

Variation with Conditions.

Statements are made to the effect that the hotter the climate in which the seed matures the greater its oil-contents. The first indication of this idea is in the following sentences from the

Annual Report of the United States Department of Agriculture, 1870, p. 93 :—"It is possible that the farther south the nut is grown the more oil will be developed in the seed. The Algerian growth furnishes 25 to 27 per cent. The quantity of oil in the Virginian growth is less than that of Algiers." The last is in the new edition of Semler's *Tropische Agrikultur*, ii., 1899 [dated 1900], p. 457, where we read :—"Like castor-oil seeds, ground-nuts are richer in oil the more tropical the climate under which they are cultivated. West African nuts from near the equator contain 50–55 per cent. of oil, North American only 25–27 per cent., and at times only 20 per cent." Despite the important bearing of such a generalisation, we have been unable to find trustworthy analyses which can be produced in support of it. Those which have been given above emphasise racial differences rather than variations due to the available solar energy. The contention is, however, plausible enough, and may be illustrated by bringing forward the relative poorness in oil which makes nuts from Virginia and the more northern States to be preferred for eating over those from Georgia, Tennessee, Florida, &c.

Proceeding to the effect of the soil upon the plant, there is indication that the oil-contents of the seed fall short in poor soil. Subba Rao (*Bulletin, Dept. Land Records and Agric., Madras*, 1893, p. 280) says the seeds from soil new to the crop are richer than those from village sites, and from red sandy loams richer than those from clays. Seed produced on unirrigated land is richer in oil than that produced under irrigation.

We have to notice next that the pods take upon them the colour of the earth in which they are buried ; red earths produce red pods, and the first ripe pods of a crop are deeper in colour at harvest from having remained longest under ground. There is a set among cultivators and merchants alike against dark-coloured pods which makes such unwelcome. Moreover, in India seed grown on certain dark soils ("pottai-mannu" soils) is rejected for sowing (Subba Rao, in *Bulletin, Dept. Land Records and Agric., Madras*, p. 263). Want of lime causes empty pods. Rich nitrogenous manures promote growth of the vegetative parts, but, so it is said, do not stimulate seed formation.

Soft earth is desired for the burying of the seed, and the practice of earthing-up, done we are told as often as 4–7 times in Spain, is an aid to this end. On hard soils the pods die whenever they fail to penetrate the surface.

The vigour, yield and colour of the seed are thus affected by the soil, and it is further said that an erect habit is at times produced by the soil (Watt, *Agric. Ledger*, 1893, No. 15, p. 9). The oil-contents of the seed appear to be increased or diminished according to the amount of heat available to the plant, but the statements by various writers are too contradictory to allow an unqualified statement.

Uses.

Chief and foremost amongst the uses to which this plant is put must be placed its yield of oil. The trade between the tropics and Europe, by which India and Africa pour the seeds they produce into modern oil mills in France, Germany, England, &c.,

is of recent growth. Older than it is the primitive method by which the negroes both of Africa and America extract a portion of the oil for their service.

The oil, which closely resembles olive oil, replaces it largely in Europe, and is used as salad oil, also in soap-making, burning, dyeing, tanning, and cloth-cleaning. It enters into such salves as cold-cream, pomades, &c. As an oil for lubricating it has some use, and it forms a very important ingredient in the manufacture of oleomargarine. It also forms an adulterant of olive and almond oils, and is in its turn adulterated with poppy, sesamum, and cotton-seed oils.

In India the sweet oil of the bazaars is a mixture of this with safflower and sesamum oils, the seeds being pressed together (Dymock, *Materia Medica, India*, ed. 2, p. 246). Arachis oil finds a further use as an adulterant of "ghi," or clarified butter, and is recognised as officinal in the Indian Pharmacopœia replacing olive oil.

Almost wherever grown, a portion of the produce is converted into oil for local use. In Java it has long served as an oil for illuminating, and for a less period in India. It burns with a clear and smokeless flame, and lasts longer than olive oil in the proportion of $9\frac{1}{2}$ hours to 8 hours per oz., but gives less light.

Japan and China produce a small quantity of oil, which, however, hardly finds its way into the European market, as in a small measure does that from India. In China a medicinal value is attributed to it (Debeaux, *Sur la pharmacie des Chinois*, Paris, 1865, p. 68).

The use of the seed as a food is very extensive. It may be eaten when unripe, and has then, when cooked, the flavour of kidney beans. When ripe, it is too oily to be more than an adjunct to the diet, and Monteiro (*Angola and the River Congo*, i., p. 131) narrates how a balanced food is obtained by the negroes by adding to it such starchy fruits as bananas. Roasted in the shell it is sold in immense quantities in the streets of the cities and towns of Eastern North America.

These seeds in Europe have served as adulterants for coffee, cocoa, and spices. For adulterating coffee they are pressed in moulds and passed as coffee beans (Vogl. *Die wichtigsten vegetabilischen Nahrungs u. Genussmittel*, Berlin, 1899, p. 321). The liquor from them is a clear reddish-brown with little taste. "Austrian coffee" is the name by which this counterfeit product goes. As cocoa they are pounded and mixed with the true material, and the Algerian name "Cacaouette" has reference to this use. Sweetmeats are made from them to a small extent.

The seeds ground finely after being roasted make a butter-like mass, sold as "Pea-nut butter" in the United States (*Agricultural Journal, Natal*, ii., 1899, p. 437). Monteiro, again, states that such a preparation highly seasoned is used to stave off hunger by the people of Angola when on the march. Pounded nuts in the tropics enter into stews and curries. The roots are said to have been used for adulterating liquorice.

The cake left after oil-expression as performed in European mills is a valuable animal food, and some use of it for human beings has been made recently. The meal which the more

primitive mills of China, Java, and India leave serves as a manure in these countries.

The hay is rich in feeding stuffs, as analyses shew (see Uhlitzsch in *Die landwirtschaftichen Versuchs-Stationen*, xli., p. 388, and *U. S. Dept. Agric., Farmer's Bull.*, No. 25, p. 5). It is made use of in Asia to a small extent, and on a larger scale in the Eastern United States. Here, too, after the harvest is gathered hogs are turned on to the land, and grub up pods which have not been collected.

As a green manure for the tropics Arachis has been suggested, for it adds when ploughed in, not only the materials drawn directly from the soil, but also the other food stuffs taken from the air, including the nitrogen which the root tubercles acquire.

Chemistry of the Seed.

Analyses of the seed shew, as already stated, a richness in oil which varies considerably. This oil is a non-drying oil, becoming turbid at + 3° C., and congealing at − 3° C. It consists of the glycerides of four fatty acids, viz. :—olein, arachin, hypogæin, palmitin.

The similarity of ground-nut oil to olive oil is apparent when we remember that the main constituents of both are olein and palmitin.

Starch is present to a small amount.

Albuminoid matter is more abundant, and cane sugar has been detected (Schulze & Frankfurt in *Zeitschr. für physiolog. Chemie*, 1895, p. 511.)

Oils, starch, and albuminoids when found in seeds are reserves for the use of the young plant and are absorbed in germination. Immediately growth starts absorption of these products commences, and the chemistry of the seed is considerably altered. In the place of the fats appear the corresponding fatty acids and glycerine. Obviously oil extracted at this juncture will not have that freedom from taste in which should lie its real value.

We cannot record observations made directly on *Arachis hypogœa*, but analogy indicates that oleic, arachic, hypogæic, and palmitic acids appear in the seed when germination has commenced.

The same acidifying process is produced by fungi, and as these readily attack the seed rancidity is developed when they are present.

It is well known that seeds of many plants cannot be induced to germinate until they have passed a certain period of quiescence. This is not so with *Arachis hypogœa*. At any time a small amount of moisture is sufficient to start the process ; so readily is it induced that occasionally in India germination starts before the crop is dug. Germination started and then checked results in the death of the seed. Such a dead and partly germinated seed contains rancid oil.

A similar amount of moisture will favour the growth of moulds —*Eurotium*, *Penicillium*, &c.—and these finding entrance into the tissues of the seeds by bruised places add to the acidity. Unfortunately Indian nuts shelled by being beaten and thus

bruised, shipped or even stored damp, become rancid ; and experts maintain that they can distinguish oil-cake made from this source by the abundance of fungal threads in it.

Ground-nut seeds do not require much moisture to stimulate growth, though in the complete process of germination they absorb almost their own weight (Bogdanow, see *Just's Bot. Jahresbericht*, 1887, i., p. 207) ; light does not conspicuously deter it (Pauchon in *Ann. Sci. Nat.*, sér. 6. x., p. 98).

The great precautions necessary to prevent growth in seeds reserved for sowing will be mentioned under the head of cultivation. There is reason why the same precautions should not be neglected in the case of seed destined for the oil-mill.

Origin and Dispersal.

That *Arachis hypogæa* is of South American origin admits of no doubt. Writers of fifty years ago, not as abundantly provided with evidence as we are, incorrectly placed its home in the Old World. Those who wish to read the arguments for its origin in America will find a masterly summary in De Candolle's *Origine des plantes cultivées*, to which very little can be added. When the Spaniards were colonising the New World they found that the Indians knew and grew the plant, and one—Oviedo, who was a director of mines in Cuba from 1513 to 1524—says that it was very abundant in their gardens. How long they had grown it we cannot guess, but we find evidence that it was more or less a staple food with them from the occurrence in Peruvian tombs of seeds left with the dead as food for the departed soul on its journey. In the tombs at Ancon, interments of not later date than Pizzaro's conquest of Peru, no seed except that of the maize is more abundant (Rochebrune in *Actes Soc. Linn. Bordeaux*, sér. 4, iii., p. 350).

The French colonists sent by Admiral Coligny to the Brazilian coast became acquainted with it in 1555, and Jean de Léry described it unmistakably.

Ficalho (*Plantas Uteis da Africa Portugueza*, Lisbon, 1884, p. 136) shows that the first distinct mention of its cultivation in Africa is by André Alvares de Almada who published in 1594 an account of travels on the Senegambia coast undertaken thirty years earlier. It was seen by him in considerable quantity in the Archipelago of Bujagoz (Bissagos). Portuguese voyagers of the sixteenth century were ever ready to leave economic products on new shores. The work of colonising St. Helena was begun by them at its very discovery (Melliss, *St. Helena*, p. 2), and probably in the same way Arachis was left on the shores nearer home which we know they frequented for two centuries from this date in pursuit of slaves. Hawkins, our English navigator, led slave-hunting expeditions to this part of Africa, and in 1564 visited the Bissagos Archipelago for the purpose ; the narrative of his second voyage frequently mentions the Portuguese. These facts are given because Ficalho argues the possibility that the ground-nut is alike native in America and Africa, and in order to show that between the date of the discovery of America and that of Alvares' travels, there is time for the establishment of Arachis

in frequented parts. Then, as later with the Arabs, it was the practice of the slavers to ally themselves with a native king in order to raid another's territory.

Clusius (*Rariorum Plantarum Historia*, ii., p. 79, 1601) informs us that the slavers took as food for their captives on the voyage from the Guinea Coast to Lisbon, roots of the sweet potato, which is an American plant, "besides certain nuts"; and these nuts Sir Hans Sloane (*The Natural History of Jamaica*, i., p. 184, London, 1707) identifies as fruits of Arachis. Though Clusius does not give information which puts Sloane's identification beyond doubt, the fact that in the latter's day these seeds were used "to feed the negroes in their voyage from Guinea to Jamaica" is itself strong evidence. And though in 1707 the earth-nuts thus used were brought from Africa with the slaves, a century earlier they were evidently brought from the West Indies (St. Thomas, &c.) with the roots of the sweet potato.

The spread of Arachis in Africa must have been rapid. It is now grown from the Mediterranean almost to the extreme south. Ficalho adduces this wide extension in the continent as an argument against an introduction subsequent to the discovery of America. But other undoubtedly American species have now a similar range, having reached the very heart of the continent from the east and west coasts (P. Ascherson in *Sitzungsbericht d. Gesellschaft Naturforschender Freunde zu Berlin*, 1877, pp. 141–157), nor are parts unknown to which its extension has only just reached (Stuhlmann, *Mit Emin Pascha*, Berlin, 1894, p. 498).

Nearly as early, some region in Malaya or South China seems to have received the plant, which spread rapidly and deceived Loureiro into calling it, in 1790, a native of Cochin China. Rumpf saw it in Amboyna and figures it (1691) as *Chamæbalanus japonicus*. The people of South China seem to have early taken to its cultivation, and thence it spread to Japan and Bengal, getting for itself in both countries, as well as in Java (Hasskarl, *Hortus Bogor.*, p. 233), a name meaning "Chinese bean." It is interesting to note in passing that, according to Bretschneider (*Study of Chinese botanical works*, p. 18) one of its names in China is "Foreign bean." Africa seems to have sent it to the Bombay coast of India a century ago, and about Bombay it has the name of "Mozambique gram" (Dymock, *Materia Medica India*, ed. 2, p. 247). Madagascar, Mauritius, Réunion, &c., have probably received it from the same source.

To North America it spread more than a century ago, and it was cultivated by the slaves in Carolina in the eighteenth century. There is evidence that it was grown in Virginia in 1781 (Sturtevant in *American Naturalist*, xxiv., p. 150).

At the end of last century its cultivation as a crop in Europe was first attempted; and at a later date Australia and some of the Polynesian islands received it.

To how wide a range of latitude it is suited is shown by this extensive dispersal. Probably the furthest north to which it can be grown is in Central Europe, *e.g.*, Austria; in the United States it is grown to 38° N., while the furthest south at which it is found is 30°–35° S. latitude.

Mention has been made of the use which the slavers made of ground-nuts as food for their captives. They drew their supply at first, it seems, from the West Indies; later it came from the Guinea coast. This traffic and attempts to grow the nut in other more northern places helped to familiarise industrial Europe with it.

Even as early as 1697 Stisser grew it in Brunswick (Flückiger and Hanbury, *Pharmacographia*, ed. 2, London, 1879, p. 187); in 1712 it had been cultivated under glass in England (see *Trop. Agriculturist*, iii., 507), and in 1723 it was in the Royal Garden at Montpellier, where, however, it soon died out (Heuzé, *Les plantes industrielles*, ii., Paris, 1893, p. 130). Tenore says that in 1774 it was again in England; and in 1769 Sir William Watson showed pods and the oil to the Royal Society, while he read a memoir on it, communicated to him by George Brownrigg of North Carolina (*Phil. Trans.*, lix., pp. 379–383).

In 1787 a great quantity of seed was brought to Spain and Portugal, where its cultivation promised well, and it is of great interest to learn from Tenore, who himself experimented with it in Italy (*Napoli, Atti Ist. Incorr.*, i. (1811), p. 31), that in 1807 the uses of its seeds were to yield an oil for soap-making and as a substitute for almond oil in pharmacy, while powdered, they served as a substitute for cacao ($\frac{1}{3}$ Arachis seed mixed with $\frac{2}{3}$ Cacao), or were added to flour in making bread. France was anxious to obtain it, and from Heuzé's account—more correct than that of any other recent writer—the following is borrowed :—

"In 1801, Lucien Bonaparte, then Ambassador at the Court of Madrid, sent seeds to M. Méchin, prefect of the department of Les Landes (the province to the south of Bordeaux), suggesting that he should try to grow it on the sandy soil of those parts. When the first trials had succeeded, M. Méchin printed a detailed account of how to cultivate it and circulated it among those who were willing to repeat his experiments. As a result Arachis was widely grown on a large scale in the departments of Basses-Pyrénées, Pyrénées-orientales, Gard, Bouches du Rhône, Vaucluse, Isère, Aude, and Drôme. Everywhere people were convinced that it was a reliable oil-seed, and would assuredly grow in Southern France. The political troubles of 1808 to 1815 stopped the experiments, and the cultivation of Arachis was abandoned. Again in 1820 to 1822, at the time when the olive-yards were in a large measure destroyed by frost, fresh experiments took place, ill-conceived, ill-directed, and without result. The farmers who had undertaken them, in abandoning the enterprise, reported that shelling the seeds was necessary before obtaining the oil, and that this was a difficult operation, and, secondly, that there was no market for the oil."

Again, the winter of 1830 wrought serious havoc in olive-yards (Coutance, *L'Olivier*, Paris, 1877, p. 210), and for some time olive oil remained at a high price. This led the wool-carders to seek some lubricant as a substitute. Ground-nut oil, in 1837, was found to serve. A Marseilles firm had put on to the market as an experiment some four or five kilogrammes (Dumas ex Poiteau in

Ann. Sc. Nat. sér. 3 xix., p. 270) derived from the crushing of seed sent from Gambia. From this the trade takes its origin. French settlements benefited first, and Gambia, where they possessed one, as well as Senegal sent increasing quantities to Marseilles year by year. Other parts of Africa commenced to export nuts, notably Algeria, Sierra Leone, and Angola. Pondicherry, too, began to send shipments, and the trade thence received a great stimulus by the opening of the Suez Canal in 1869.

Some idea of the growth of the trade may be obtained from the statement that ten or twelve years after the first importation the output of Marseilles had reached seventy million kilogrammes of oil (1,377,482 cwt.). Barcelona, near which, as already mentioned, experiments in growing Arachis had commenced in 1787, entered into competition with Marseilles. Spain proved not unsuited to the crop, and thence comes the record that 700 pods have been obtained from a single root; but the output of oil from Spain is not great.

Another attempt at production in France took place in 1839 and 1840, when a M. Chaise, who had been in Senegal, grew near Dax some five hectares (12⅓ acres), with results beyond his expectation. Still, as Naudin reports (Naudin and Mueller, *Manuel de l'Acclimateur*, 1887, p. 139), the cost of production was too great, and despite M. Chaise's big crop no further attempts to produce the plant in France have occurred. From Losoncz in Hungary a more recent successful attempt is reported (*Just, Jahresbericht*, 1878, ii., p. 478) but it is not clear that profit can be derived.

The trade in ground-nuts thus remains one by which the tropics feed the mills of Europe.

Genoa, Bordeaux, Nantes, Dunkirk, London, Rotterdam, Hamburg, and the Baltic ports have entered into competition with Marseilles, and the Mozambique coast of Africa has commenced to export in large quantity.

In this process of decentralization, though France still remains *facile princeps*, Marseilles no longer holds the same large share in the commerce which fell to that port thirty years ago. Almost 100 million kilogrammes of Arachis were imported into France in 1898, chiefly in the pods, but partly decorticated, to a value of over £836,000, and representing 76,900,984 kilogrammes of kernels. In the same year Marseilles imported Arachis to the amount, represented as kernels, of 27,098,100 kilogrammes. The proportion of the trade which fell to Marseilles was then a trifle more than one-third of the total of France.

The figures upon which the above statement is based were kindly supplied to Kew by the Statistical Department of the Board of Trade. From figures from the same source the following table of recent imports to France has been calculated :—

Average.	In the shell.	Decorticated.	Total as kernels.
1892–4	75,123,313	105,816,151	163,661,102
1895–7	57,516,807	46,791,922	88,513,197
1898	93,684,247	4,764,114	76,900,984

The imports of Germany, which between 1880 and 1887 (Uhlitzsch, *l.c.*, p. 397) averaged 8,395,000 kilogrammes have increased so that during the last three years they have been :—

Year.	Kilogrammes.
1896	12,390,600
1897	15,187,800
1898	12,776,100

Italy, too, has increased her imports of oil-seeds, but no special statistics for ground-nuts are available.

Supply of Europe.

Gambia, which sent 13,200 cwt. to Marseilles in 1837, was followed by Senegal in 1840 with a small shipment. The increase in the exports then became rapid. In 1860 Gambia exported to the value of £79,612, and Sierra Leone to £34,514 : in 1870 these two colonies exported the one to the value of £121,329, the other to £95,605 ; and the trade became the most important one of this part of Africa, and continues to be so.

Angola entered into competition with Gambia but heavy taxation checked and partly destroyed the Angolan trade (Monteiro, *op. cit.*, i., p. 133, and Ficalho, *op. cit.*, p. 139).

The Indian trade, owing to the length of the journey round the Cape, took no great dimensions until after the opening of the Suez Canal in 1869. Then came a rapid development, Pondicherry being the chief centre. Indigo had been a leading concern of this French settlement, but the natives who dealt in it suddenly discovered that Arachis offered a better market, and for a time the trade taxed the capabilities of the port to the uttermost. In 1883 the demand for storage space was so great that every available dwelling-house was rented by the merchants. In 1886 three special "nut" trains had to be run daily for some time from Panruti in the chief producing district to Pondicherry, while Pondicherry, Panruti, and the surrounding villages remained full of them (*Trop. Agriculturist*, iii., p. 12 ; vi., p. 31). In 1891 space was totally inadequate to meet the increased traffic, despite the use of "twelve new export sheds and ten large naval coal go-downs" (*Trop. Agriculturist*, x., p. 867).

About three-quarters of the nuts exported from Pondicherry were grown in the British territory adjacent to the French settlement. Nuts likewise found an outlet through Madras, and those produced in the Bombay Presidency through Bombay.

Statistics are available of the exports from British India, but not from Pondicherry ; under these circumstances it is hardly useful to give them. As a substitute a table is offered of the acreage under the crop for the years from 1882 to 1898 in the Madras Presidency ; it shows the increase to the climax in 1890 and the subsequent fall. The figures are taken from Subba Rao's paper quoted before, and from the *Revenue Report* on the crop in Madras (G.O., Nos. 773, 773A, p. 7).

Acreage under Ground-nuts in the Madras Presidency.

Year.	Acres.	Year.	Acres.
1882–83	73,568	1890 91	258,313
1883–84	98,536	1891–92	201,344
1884–85	145,976	1892–93	226,905
1885–86	161,607	1893–94	247,796
1886–87	153,013	1894–95	226,147
1887–88	141,507	1895–96	243,350
1888–89	211,890	1896–97	157,234
1889–90	279,355	1897–98	83,715

The fall in interest subsequent to 1890 is not peculiar to Madras, it is observed, too, in the Bombay Presidency, and the French Chamber of Commerce at Pondicherry has recognised the necessity of investigating the cause, while the decreased imports to Marseilles have caused concern there.

As most of the nuts sent to Europe from India are decorticated first and those from Africa are sent undecorticated, we can recognise the effect in the following table of Marseilles imports. In the third column the total imports are calculated as kernels, *i.e.*, 23 per cent. of the weight of undecorticated nuts is deducted for the shell. The basis of the table is one in the *Comptes Rendus de la Chambre de Commerce de Marseille*, 1897 and 1898, and the proportion of kernel to husk is based on figures given by Uhlitzsch (*l.c.*, p. 388). Simmonds (*Tropical Agriculture*, London, 1877, p. 402) only allows to the husk 1 per cent. of the total weight—an impossibly small amount; Heuzé gives it as 26–28 per cent., and in some pods weighed at Kew, in a very dry condition, it was found to be about 25 per cent. To place 77 per cent. to the kernel is therefore a liberal allowance.

Average annual Import of Ground-nuts in quintals into Marseilles in periods of three years. (1 *quintal* = 110¼ *lbs. or approximately* 1 *cwt.*)

Years.	Undecorticated.	Decorticated.	Total as kernels.	Decorticated. Average price per 100 kilos.
				francs.
1877–79 ...	584,782	69,532	519,814	43
1880–82 ...	627,579	316,930	800,166	35
1883–85 ...	398,700	499,612	806,611	33
1886–88 ...	124,535	739,408	835,301	28
1889–91 ...	208,740	1,084,023	1,244,753	28
1892–94 ...	336,147	1,010,517	1,269,350	26
1895–97 ...	265,407	464,473	668,836	26
1898	632,860	54,660	541,962	—

It is true that the export of oil from Madras, &c., has slightly increased, as the next table below shows, but this is in no measure proportional to the great decrease in exports of nuts.

Export of Oil in Gallons from Madras Presidency.

	Foreign.	Coastwise.	Total.
Average of 5 years ending 1887–88 ...	6456	266,925	273,381
„ 3 „ „ 1890–91 ...	7126	46,919	54,045
„ 3 „ „ 1893–94 ...	7907	14,997	22,904
„ 3 „ „ 1896–97 ...	1459	609,790	611,249
Year ending 1897–98 ...	3049	508,254	511,303

It seems that to meet the demand in Marseilles in 1898 large shipments were made of undecorticated nuts from Africa, and judged by the extensive cultivation on that continent it is possible that the demand may be fully met. The possibilities of the West Coast of Africa are not yet fully developed. W. W. A. Fitzgerald remarks (*Travels in Coast Lands British E. Africa*, p. 213) that "The soil of the coast lands is just what is required for its cultivation."

Exact information on the subject of the trade of this side of Africa has hitherto been wanting, and in view of the evidently considerable possibilities the following abstracts from a report by H.M.'s Consul at Mozambique will be of interest.

"The ground-nut is collected by natives, by whom it is largely used as an article of food; it is also sold by them in great quantities to the Indian merchants or to the holders of Prazos (*i.e.*, tenants), by whom it is either passed on to European firms on the coast or exported independently.

"From such statistics as I have been enabled to obtain from the Portuguese Custom Houses on this coast it would appear that the bulk of the ground-nuts which find their way to Europe from Portuguese East Africa are shipped from the northern ports of the province, that is to say, from Ibo, Mozambique, Quilimane, and Chinde. It is evident from the figures I have received from the three first-named places that Quilimane is by far the most important of them in relation to this commodity; but although, unfortunately, I have been unable to procure any precise information from the Custom House at Chinde, I am able to state from my personal knowledge of the place that the output from Chinde approaches that from Quilimane, its neighbouring port. This will be the more readily understood, perhaps, when it is explained that Chinde receives the entire trade of the extensive Zambezi valley, and, similarly, all the articles of import received, not only from the Zambezi, but from the vast countries to the north and west, are shipped from Chinde. It will, therefore, be seen that the amount of ground-nuts exported from the two places is very large. Moreover, there has been established at Quilimane during the past year an extensive soap and oil manufactory, which possesses certain profitable monopolies for the manufacture of those two articles in the province and elsewhere. As these goods are manufactured entirely from ground-nuts and other locally produced oil seeds, it follows that a considerable quantity is used in this way. If we were in a position to add to the quantity of ground-nuts actually exported from Quilimane and Chinde the number of tons used locally in the soap and oil manufactory, the amount of this produce collected in the district,

with that shipped from the Zambezi, would doubtless reach an astounding total.

"On the table which follows it will be noted that the increase in the exports of ground-nuts in 1898 is considerable, and this is the more remarkable when it is understood that the natives in the northern portion of the province have often great difficulty in reaching the coast with their produce by reason of the terror inspired by the marauding tribes by which the country is infested. I am informed that a large quantity both of rubber and ground-nuts is annually lost to commerce, the natives being surprised in the act of conveying it to the coast and put to flight, while the result of their labours for, it may be, many months is left rotting on the ground.

"As I have previously endeavoured to explain, the ground-nuts are collected entirely without supervision, and in quite a haphazard way, and sold to the exporter on the coast. From what I have been enabled to glean very few find their way to the United Kingdom, the bulk going to Hamburg and Rotterdam, whilst a certain quantity are despatched to Marseilles."

Return of Ground-nuts exported from below-mentioned Ports in 1897 *and* 1898.

Ports.	1897.		1898.	
	Tons.	Value.	Tons.	Value.
		£ s. d.		£ s. d.
Ibo	55	742 10 0	85	1,147 10 0
Mozambique	2,065	27,877 10 0	5,190	70,065 0 0
Quilimane	2,470	33,345 0 0	6,397	86,359 10 0
Chinde (approximate) ...	2,000	27,000 0 0	4,500	60,750 0 0
Total	6,590	88,965 0 0	16,172	218,322 0 0
	Total export during 1897		6,590	88,965 0 0
	Increase during 1898 ...		9,582	129,357 0 0

Like the Indian trade, that of the Argentine Republic, never very large, has fallen since 1891; a table of the importations of Europe thence may be seen in Semler's *Tropische Agrikultur* (ed. 2, ii., p. 461).

Lastly, a word about China. China, as stated above, an early home of Arachis in Asia, still grows large quantities, especially in the Yangtze-Kiang valley. Chief of all as a port of shipment, not only of nuts, but of oil, is Chinkiang, at the mouth of this river, and a large proportion of the exports finds its way to Hong Kong thence to be shipped to other countries. Shanghai, too, in the same region sends a considerable quantity of oil to Hong Kong, as also Chefoo in the north, and Pakhoi in the south. In the extreme north Tientsin has a large trade in nuts, but for the most part internal. Besides Hong Kong, Swatow Lungchow and Chefoo export nuts and oil from China to foreign countries, but in small measure, and the effect on the European market remains very small.

Demand and Production in the United States.

After the Civil War there sprang up in the cities and towns of the Northern United States a liking for roast ground-nuts, which are sold in the streets at every corner. The soldiers of the northern army brought back the taste for them as a result of their invasion of the south (*Annual Report, U.S. Dept. Agriculture*, 1868, p. 220). Both armies had occupied Virginia in turn, where the farmers all grew small patches for their own use.

Reference to the Monthly Reports issued by the United States Department of Agriculture enables us to follow the growth of the demand.

In those for 1869 we learn that in Virginia tobacco land which did not pay was being put to the new use of growing pea-nuts. In those for 1870 an account of the North Carolina crop is given showing its extension. In 1871 (see *Reports* of that year, p. 494) the crop of Virginia had reached 225,450 bushels, in 1874 (*Reports* for 1875, p. 512) it had reached 382,610 bushels, and in 1882 (Jones, *The Pea-nut Plant*, New York, 1896, p. 66) it reached 1,250,000 bushels. Other States meanwhile were growing pea-nuts, and Tennessee, in which it was extending in 1872 (see *Reports*, p. 488), produced in 1882 460,000 bushels, while North Carolina raised in the same year 140,000 bushels.

The heavy demand and insufficient production within the United States fostered a trade between Africa and New York, &c., which the increase of internal cultivation, as shown above, and a tax on all nuts imported from Africa ultimately more or less arrested. Statistics derived from the *Year Book of the U.S. Department of Agriculture*, 1897, p. 340, demonstrate the decrease.

Average Annual Import of Pea-nuts and other Ground-nuts into the United States, by decades.

Years.	Quantity.	Value.
	Lbs.	$
1865–1870	6,522,844	184,465·49
1871–1880	1,849,645	46,662·16
1881–1890	170,593	3,314·24
1891–1897	149,672	2,655·13

Shelled pea-nuts being excluded from the preceding table, that which follows from the same source supplements it.

Average Annual Import of Shelled Pea-nuts and other Ground-nuts into the United States, by decades.

Years.	Quantity.	Value.
	Lbs.	$
1865–1870	391,006	13,713·89
1871–1880	375,342	14,974·95
1881–1890	54,960	2,223·97
1891–1897	21,658	2,623·09

The imports of decorticated nuts in 1897 were only 1,000 lbs., of ground-nuts in the shell, 138,102 lbs.

The exclusion of foreign nuts is well shown by the above figures, which may be taken in conjunction with the statements that in years of low prices the cost of transport precluded the importation of African nuts (*Journ. Applied Science*, 1881, p. 81), and that in 1894, owing to the tax, nuts sent from Africa met with no market (*U.S. Consular Reports*, Oct., 1894, p. 240).

Expression of the Oil in Europe.

The oil is expressed from the seeds in the following manner, as described by Dr. P. Uhlitzsch (*Die landwirtschaftlichen Versuchs-stationen*, xli., 1892, p. 400) :—" When by means of brushing the pods the unshelled nuts have been cleaned, they are broken between rollers and passed on to a fan which winnows out the light pieces of husk. When the seeds are sufficiently broken they are packed into a cylinder in thin layers, each layer separated by a cloth of horsehair. The first pressing is but slight, the resulting cakes are very flat, loose, and easily broken. The cakes are then broken and ground up finely in a mortar, sprinkled with water and mixed with any meal which passed through the holes in the cylinder at the first pressing. Then follows the second pressing. Mills which only make table oil express twice in the cold, or on the second occasion in very slight heat ; but usually the nuts are pressed three times.

" The first expression in the cold gives an almost colourless oil with agreeable taste and smell, which serves as a pure table oil, and is used for making oleo-margarine ; the second yields a 'sweet oil,' and the product is also used for burning ; the third expression, made with heat, gives an oil—rabat oil—of a yellow colour and hardly agreeable taste and smell, which is used in soap-boiling.

" By these different pressings 30–40 per cent. of the oil is removed in something like the following proportions :—

" 1st expression, 16–18 per cent. of a fine table oil.
" 2nd „ 7–8 „ of a table oil or illuminating oil.
" 3rd „ 7–8 „ of an indifferent oil.

" The oil-cake left contains about 7·5 per cent."

Such is the result of expression carried on at the mills of Hamburg, Berlin, Marseilles, Rouen, &c. According to Heuzé, the nuts in Spain, when pressed as soon as gathered, often give 60 per cent. ; in Italy 50 per cent. is obtained, in India, 43 per cent., in Senegal, 30–33 per cent., and at Pondicherry, 37 per cent.

The bags used in the process are made of horse hair or wool. The cake varies in shape according to the machinery used. Those made in Riga are twice as long as those made in West and South Germany.

When it is intended to devote the whole of the oil to soap-boiling, chemical means are used in its extraction—carbon bisulphide, petroleum-ether, benzene or canadol. The use of such substances as carbon bisulphide obviously leaves the cake unfit for food.

The Indian Oil Mill.

The Indian oil mill was described by Subba Rao in the *Bulletin of the Department of Land Records and Agriculture, Madras*, p. 283 (No. 28, 1893), in the following way :—

"The oil is expressed locally in native mills of the ordinary rotary pestle-and-mortar pattern. The chief centres of this trade are Valavanur (700 mills), Panruti (200 mills), and Pondicherry (200 mills). A single charge for a mill is from 15 to 18 Madras measures of seed (about 15–18 lbs.), which must first be thoroughly dried. During the pressing water is added to the seed in small quantities. After working for about half-an-hour, oil begins to collect and the kernels to cake. The cake is then loosened with a crowbar, and about $\frac{1}{4}$ lb. of old ground-nut cake dust is mixed with the mass, and work is then resumed. In 45 minutes from the commencement of the work about three measures of oil are ladled out of the mill. The cake is again loosened from the sides of the mill and the crushing continued. About five minutes afterwards a strip of cloth is dipped in the mill and the oil absorbed is squeezed into the pot. In this manner about a measure of oil is taken out. Thereafter the oil is taken up on a brush or a bunch of fowl's feathers and squeezed out into the pot. The cake is then again loosened and broken up. About an hour after commencing the work, the oil collected in the lower cavity is removed by a strip of cloth fastened to an iron rod about 2 feet long, which is dipped into it. In this manner another measure of oil is removed. Then another handful of ground-nut cake dust is added to prevent the adhesion of the cake to the pestle. After about one hour and a quarter a torch at the end of an iron rod is lit and moved slowly all round close to the cake while the mill is working. For about 10 to 15 minutes the cake is thus heated, the object being to increase the out-turn of oil. In an hour and a half the work is over and the cake is dug out and put by. The last of the oil (about $\frac{3}{4}$ measure) is taken out. In North Arcot and Chingleput districts the use of the torch in connection with the work of the oil mill is unknown. The out-turn of oil is about 25 per cent. by measure, or 33 to 37 per cent. by weight of the kernels crushed. The oilmongers are paid for crushing the seed Rs. 7 or Rs. 8 per candy of oil delivered to the merchants."

Oil-expression elsewhere.

In China, Java, and Japan, a certain amount of oil-expression is done. No one, it seems, has described the Chinese mill used for the purpose, but presumably it is the same as that used for expressing other oils.

In Java the seeds are dried in the sun before being passed into the press.

The method of obtaining the oil in Angola is thus described (Monteiro, *Angola and the River Congo*, i., p. 132) :—

"The nuts are first pounded into a mass in a wooden mortar; a handful of this is then taken between the palms of the hands,

and an attendant pours a small quantity of hot water on it, and on squeezing the hands tightly together the oil and water run out. Since the great demand for, and trade in the ground-nut, but little oil is prepared by the natives, as they find it more advantageous to sell the nuts than to extract the oil from them by the wasteful process I have just described."

Oil-Cake.

After the expression of the oil a rich cake remains. This has been extensively used as an animal food, and when more or less free from fragments of shells and adulterants such as the starchless crushed seeds of the poppy—the commonest admixture—is of high nutritive value.

Naturally the composition of the cake varies considerably according to the degree of completeness in which the oil has been removed. Subjoined are five analyses, drawn from various sources; in the sixth column is the mean of seven closely similar analyses given by Dr. Uhlitzsch (*l.c.*, p. 413).

	Nördlinger, ex Masori in *U.S. Consular Reports*, April, 1894, p. 686. Pea-nut grits made from (? German) cake.	Muters in *Food Journal*, iii., (1873), p. 104.	Voelcker in *Improvement Ind. Agric.*, p. 417; made from Indian cake (de-corticated).	Tuson in *Pharm. Journ. and Trans.*, Ser. 3, vii., 332, made from Mar-seilles cake, 1876.	Watt in *Agricultural Ledger*, 1893, No. 15, p. 31, made from Cal-cutta cake.	Uhlitzch in *Die land-wirthsch. Versuchs-Stat.* xli., p. 413; essence of seven analyses made in 1892, from cakes chiefly German
Water	6·54	9·6	8·10	9·58	10·10	8·6
Oil	19·37	11·8	7·26	7·40	9·16	7·4
Nitrogenous Matter ...	47·26	31·9	47·81	42·81	48·55	48·1
Starch and digestible fibre.	19·06	37·8	25·02	27·63	22·53	23·5
Indigestible fibre ...	3·90	4·3	4·86	7·87	4·73	5·1
Ash	3·87	4·6	6·95	4·71	4·93	5·9

All these agree in allowing an extreme richness to the cake, and this is borne out by experiments in stock feeding which need not be detailed.

Subba Rao (*l.c.*, p. 283) tells us of the use of cake for human food when famine presses in India; Handy speaks of its use in the Southern States between 1861 and 1865 (*l.c.*, p. 21). Of further interest are the attempts to use it in the same way in Europe. The first advocate was Dr. Muters, whose analysis is quoted above; a second is Dr. Nördlinger. Both avail themselves of the removal of much of the oil to obtain a highly nitrogenous and nutritious food, not over rich in one of the elements of a balanced diet.

Dr. Nördlicher's preparations as made by the Rademann Food Product Factory take four forms :—

Pea-nut grits (Erdnussgrütze).
Pea-nut flour (Erdnussmehl).
Pea-nut biscuits.
Diabetic chocolate biscuits.

The first is a coarse meal, the second a flour, both giving on analysis the following :—

Water	4·8
Protein substances ...	48·5
Oil	22·0
Carbohydrates	17·9

The first kind of biscuits is composed of the pea-nut flour with the addition of a starchy flour, which raises considerably the percentage of the carbohydrate elements, while the second kind, in which starchy stuffs are a disadvantage, is composed of the pea-nut flour with no considerable admixture.

For some time the Soja bean has been employed as a dietetic for those suffering from diabetes, and Dr. Nördlinger points out that Arachis, besides being very much cheaper, has, after the extraction of the oil, a greater percentage of nitrogenous food and not much less fatty food.

Since 1893 these products have been in the market. They have further been the subject of experiment under Dr. Führbringer in a hospital in Berlin, where, it is reported, most of the patients, who were suffering from the usual variety of complaints to be met with in a public hospital, willingly eat pea-nut soup offered to them. Also the experiment of supplying them in the army rations has been tried.

It is worth noting in passing that Dr. Nördlinger's analysis—the first of the series given—shows a richer cake by far than is usual.

It cannot be denied that on chemical investigation the feeding value compared with the cost is immense. The great question is in the palatability of the products offered.

Cultivation.

It is in the Eastern United States that the greatest intelligence has been applied to the raising and harvesting of the crop. A description of the methods in vogue in Virginia may well serve as a basis for contrasting the manner elsewhere.

The soil is reduced to a fine tilth, the preceding crop—maize, cotton, or tobacco—having been one which leaves the surface in a clean condition. Probably a rich supply of marl or gypsum, if not put on the land when under the former crop, is given. Then the seed, which has been left in the pods all winter, is shelled and its power of germination tested. The farmer is advised to make more than one trial, to test a few seeds indoors first, then a larger number in the open, and not to sow till he is satisfied that he can obtain a crop. As a further precaution it is necessary,

when the shelled seeds have to be kept for some little time before sowing, to keep them in small bags or baskets, lest they heat and lose all power of growing.

The seeds are set by hand on the ridge, a bushel to a bushel and a half of pods (*i.e.*, 24–36 lbs.) giving seed enough for one acre. The ridges should be 2½–3 feet apart, and, when the plough has prepared them, an ingeniously simple machine known as the "dotter" is run along each pair of ridges before the hands, marking by means of spikes on its wheels the spot where each seed is to be set. The hands following place a single seed into each hole at a depth of 1½–2 inches, and cover it with the foot. Within seven to ten days from planting the seedling appears at the surface, and then any spots where failure to germinate has occurred are resown. The after workings are ploughings and weedings, three or four in number; in the second ploughing the earth of the intervening space is thrown towards the plants in order to help the pods to bury themselves.

The crop is sown in May, or at times late in April or in June; flowering begins in July and lasts a month. The plant can stand a good deal of dry weather.

Harvesting is commenced in the end of September and continued through October. A plough with a narrow mould-board is run along each side of the rows and the soil round the plants loosened. Then the vines are lifted by hand, shaken free of earth, and left for a day or two to wither. After this the plants are placed round stakes into small shocks, under, and often also over, which is laid a board as protection from the moisture of the soil or from rain. Thus left the pods are cured in the air. The last process is to pick the nuts, a troublesome piece of work done by hand, which is accompanied by grading and cleaning the pods for market. There also exist factories which buy the pea-nuts, clean and grade them, and sell them again. In doing this "pops," or empty pods, are removed. Such empty pods are said to be most abundant when there is a lack of calcareous food in the soil, or as an effect of dry weather.

Pods which remain in the soil are picked out as far as possible on ploughing the land, and hogs turned on to grub out and feed on what is left, lest the plant become a tiresome weed in the next crop. The hay, too, is saved in as good condition as may be for a food for animals.

Modifications of this method are commonly practised. At times the ridge system is forsaken, and planting done on the flat. As is well known the relative advantages for the two systems depend chiefly on the depth of the soil and amount of moisture available. Various mixed manures are given; and the distance between the rows varied with the variety chosen and the fertility of the earth.

Quite recently a little attention has been directed to the culture on irrigated lands (see *Bulletin, Florida Agricultural Station*, 26, 1899, p. 26), but the results are not to hand.

On land new to pea-nuts the crop is usually heavy, and the ridges are at least three feet apart. After a few years under pea-nuts the growth becomes less vigorous, and the rows may hardly meet at a distance of 2½ feet.

A striking contrast to this is the custom in Gambia to sow the rows a foot apart. Here the land is ploughed and the seed dibbled

in on the ridge as in the States. The standing crop is weeded, and ultimately ploughed up. In Angola, Monteiro tells us (*op. cit.*, i., p. 129) the ground for pea-nuts—good soil in a river valley a little way inland where the comparatively arid coastal strip ceases—is cleared and the weeds burned; then, with a primitive little hoe, women stir the soil to the depth of a few inches, and the seeds are dropped in and covered up. Put in the ground in October or November, the crop is not removed until July or August, though the nuts are ready to be eaten green in April.

In India care is taken to get the soil into a good state of tilth, and as in the United States lime is regarded as a valuable manure. Subba Rao (*l.c.*, p. 226) says that silt containing lime to the extent of 22 per cent. was applied at the rate of 100 cart-loads per acre when the land of certain villages was first brought under ground-nuts, and afterwards at intervals of a few years. Animal manure is regarded as beneficial only when applied to the preceding crop. Ashes are largely used, at the rate of 10 to 30 cartloads per acre a cart-load being about a ton. Indigo refuse is rarely used. It is considered that organic manures do harm rather than good if there be a long drought after application.

Seed required for sowing is kept in the pods until required. It is recognised that it will not keep for more than a year, and that it must be well looked after, it being desirable when the pods are in large quantities to dry them once a month. As a rule seed is shelled before sowing, but this is not always done, for sometimes one-seeded pods are picked out and sown. Shelling is done if possible not more than five days before sowing, and requires great care in order not to injure the seeds. Women perform the task, and the price paid for shelling for seed is thrice that for shelling for commercial purposes.

Sowing on unirrigated land is done between the middle of May and the middle of August, but chiefly between mid-June and mid-August. On irrigated lands the sowing does not as a rule commence till August and is continued till October. The seed is always sown thickly, 90 or even as much as 112 lbs. going to the acre. The seed is sown in the furrows made in ploughing, is always hoed in, and the fields watched against the depredations of jackals, crows, &c. It is hoed by hand during growth, and watered in January or earlier if necessary. In one place it is the custom to trample down the stems to bring them nearer to the soil.

The crop matures six months after sowing; the haulms, if forage is scarce, may be then grazed or cut for fodder, or the land ploughed and the plants lifted. Any pods on the haulms are then plucked and added to those gathered from the soil during successive ploughings or by digging. If within a week after the haulms have been gathered on unirrigated land the soil be not dug up and the ground-nuts plucked, it is said that the seed will not be good for sowing though good enough for other purposes.

Heavy rain at the time of harvest causes the seeds to germinate in the pods and great damage to the crop, including the hay.

A labour-saving device which may injure the pods is in use in some parts on irrigated ground. The ground, which must be

dry, is ploughed and then flooded; the pods, if perfectly dry, float, and can easily be swept with a broom to one corner of the field. In such a course the pods are allowed to dry for fifteen days between the ploughing and flooding, for, unless perfectly dry, they do not float, nor in any case will they float for long.

In India the produce rarely comes to the market unshelled. The pods in shelling are cracked by being beaten with a stick; the shelled seed is then winnowed and the shells used as fuel or as manure or are wasted. "Kernels" are generally sold by weight, and to increase their weight the ryots add water to the pods before shelling them at the rate of about 16 Madras measures for 1,400 Madras measures of pods.

The details of commercial cultivation in China are unknown. The nuts ripen at Chefoo in October (Williamson, *Journey in North China*, London, 1870, ii., p. 438); a light and sandy soil is chosen for their growth (Hosie, *Three Years in Western China*, London, 1890, p. 83). The earth in which they have grown may in the harvest, after a preliminary ploughing, be passed through a bamboo sieve lest any nuts should be lost (B. C. Henry, Lingnam, London, 1886, p. 239), and after the extraction of the oil the refuse is used for manure (Williams, *Middle Kingdom*, London, 1857, ii., p. 105).

Yield.

In Virginia the yield formerly stood at 50–75 bushels of pods per acre: this is equivalent to 1200–1800 lbs. It has since fallen immensely, and we read (*U.S. Dept. Agriculture, Farmers' Bulletin*, No. 25, p. 4) "within the last few years this crop has ceased to be as profitable as heretofore. The method of culture—the annual planting of nuts on the same land, the complete removal of all the vegetation from the land, and the failure to replenish the soil by means of fertilisers—has been a great factor in reducing the profits of the crop, so that now instead of an average of 50 bushels per acre, with frequent yields of over 100 bushels, the average is not over 20 bushels, while the cost of cultivation has been but slightly reduced."

Undoubtedly *Arachis hypogæa* is a most exhausting crop. Cultivators in America knew long ago that their second crop was less vigorous than the first and drew the rows closer together; but the exhaustion of the soil has been allowed to reach the extreme above depicted. Under these conditions the trade is maintained as it is, chiefly by the tax on imported nuts.

The yields obtained in the United States are far exceeded under irrigation in the tropics. Subba Rao gives the upper limit for Madras as 5,000 lbs. to the acre. According to the same writer, in the season of 1892–93, under very favourable circumstances, it reached 3,600 lbs. to the acre on unirrigated land, but the most common yields ranged between 180 and 720 lbs., *i.e.*, 7·5–30 bushels.

In Semler's *Tropische Agrikultur* (2nd ed., ii., p. 461) the yield in the Argentine is given as about 1,250 lbs. to the acre.

Holtze obtained at Port Darwin in North Australia 3,024 lbs. to the acre (Mueller, *Select Extra-trop. Pl.*, ed. 9, p. 50). Paillieux and Bois (*Potager d'un Curieux*, Paris, 1898, p. 32) give the yield

in Senegal as 2,000 kilogrammes per hectare, *i.e.*, 1,780 lbs. per acre. In his experiments in South France, mentioned earlier, M. Chaise obtained the large yield of 2,200 kilogrammes per hectare or about 1,960 lbs. (Heuzé, *op. cit.*, p. 139).

Experiments have been tried in Florida with this plant on irrigated land, but the yield is not known to us.

One thing is very evident, that the size of the crop depends largely upon intelligent cultivation.

The yield of haulms per acre is given by Subba Rao (*l.c.*, p. 275) as 1 ton per acre, by Handy for the United States as 1–2 tons per acre.

Concluding Remarks.

We have followed the history of *Arachis hypogœa* from its discovery by the early colonists of the New World to the present time, and have seen reason for tracing its appearance in Africa to the Portuguese, who traded on the Guinea Coast; we have noted its early and obscure history in Asia, and have seen how widely it is now acclimatised, and what a great part of the world is capable of producing crops of it; even in Central Europe this is possible.

Then, when the scarcity of olive oil demanded a substitute, France holding the chief trade in oil-seeds not only came forward as the market for ground-nuts, but her settlements obtained the export trade, and Gambia, Senegal, Pondicherry, and in a measure Algiers, prospered by it. Our neighbouring English possessions were not long in following suit, British Gambia gaining by proximity to the French settlements, and Madras profiting through Pondicherry. The rapid growth of the trade was most marked. At first West Africa supplied Europe, then nuts came from India, and even China and the Argentine, and now in addition there is an increasing importation from the Mozambique coast; the latter grows, while India withdraws from the competition.

Marseilles, from the first the chief market for ground-nuts in Europe, and still chief, despite the growing trade of Hamburg, London, Rotterdam and Genoa, is undergoing a crisis in its oil trade, and this, because of its connection with the decreased production of India (*see* p. 186), demands our attention.

Since 1894 the importations of oil-seeds by Marseilles have fallen; in 1897 41 per cent. (16 out of 39) of the oil mills of the city were closed, and the report for 1898 (*Compte Rendu de la situation commerciale*, p. 77) tells us that the condition of the oil trade was growing less hopeful. The difficulty of obtaining material (a result of local prices) and the flooding of the market with American cotton-seed oil are cited as causes. In fact the competition, not only in regard to cotton-seed oil, but in other oils, and with European ports, has proved too severe for Marseilles. Year after year the price offered for raw material has been reduced in order to meet the falling price of the oil. With other oil-seeds ground-nuts have fallen, and the price for unshelled nuts, which in 1877 stood at 49 francs per 100 kilogrammes, in 1898 stood at 30, and in 1895 had been as low as $22\frac{1}{2}$ (*Compte Rendu*, 1898, table at p. 81).

The decreasing interest of Madras, Bombay and Pondicherry is traceable in a large measure to these falling prices, and also

undoubtedly to the deterioration of the crops due to exhaustion of the soil. On p. 197 it was pointed out how crop after crop wears out the land. No wonder considering the richness of the material taken off in the harvest! As the farmers of Virginia have been forced to recognise, land which once yielded 50 bushels per acre presently grudgingly produces 20, and so too with the successive crops of the Indian ryot.

Freight has operated against the export trade of India. To save the considerable addition of bulk made by the husk the native has shelled his produce before shipping it, and that carelessly; fungi and bacteria thereupon commence their ravages on the broken kernels, producing deterioration which, measured by Marseilles prices, is expressed in the following table. It is calculated from data in the *Compte Rendu* for 1898, and by allowing that the husk removed takes 23 per cent. from the weight.

Prices at Marseilles in francs per 100 *kilograms.*

Year.	Undecorticated.	Estimated cost of 100 kilos of kernels in undecorticated nuts.	Decorticated.
1875...	31	40·3	38
1876...	31·5	40·9	40
1877...	34	44·2	49
1878...	33·5	43·5	42
1879...	33	42·9	39
1880...	36	46·8	39
1881...	33	42·9	34
1882...	32·5	42·2	31
1883...	35	45·5	32
1884...	33	42·9	33
1885...	25	32·5	33
1886...	22·5	29·2	26
1887...	25	32·5	28·5
1888...	27·5	35·7	28·5
1889...	25	32·5	28·5
1890...	25·5	33·1	27
1891...	27	35·1	28·5
1892...	26·5	34·4	28·5
1893...	22	28·6	27
1894...	17·5	22·7	22·5
1895...	18·5	24	22·5
1896...	18	23·4	26
1897...	22	28·6	30
1898...	22·5	29·2	30

The cake resulting from the expression of seed, much injured by fungi and bacteria is, like the oil, rancid, and if, as is probable, the fungi again assert themselves after expression, loses its valuable fatty constituents by degrees. "Ritthausen and Baumann have shown that a great loss is caused by fungi in other oil-cakes; *e.g.*, two samples of rape-seed cake containing 10·53 and 8·5 per cent. of oil, contained after two years only 1·98 and 1·87 per cent. when overrun by fungi." (Biffen in *Annals of Botany*, 1899, p. 372.)

Here lies the reason why cake from Indian seed is more or less condemned. It must be confessed that the product is not sent into the market in the best condition ; and moreover the practice of increasing weight by adding water (p. 197) or of gathering the nuts by flooding the land (p. 197) or the storage which may be necessary between the shelling and shipment cannot but be detrimental.

Obviously, then, the sooner the crop finds its way into the oil-mill, the better the oil and the cake. The short voyage between Gambia or Senegal and European ports is greatly in favour of these countries ; but the existence of oil mills in India, in China, and now at Chinde in the Zambesi delta, all places with an increasing output, indicates the possibility of the extension of crushing in the centres of production.

That there is a demand for the oil appears from statements to the effect that in the making of a firm hard soap other oils cannot readily replace it. As a table oil its use is wide, and one result of the large imports of cotton-seed oil into Europe has been to cause more of the Marseilles mills than hitherto to turn their attention in this direction. The big importation of undecorticated ground-nuts into Marseilles in 1898 (p. 187) while showing the demand, is probably an effect of this.

The Chamber of Commerce of Pondicherry aware of the decrease in their trade—for not only has the acreage under the crop diminished, but a greater percentage of the output of India has been diverted to other ports—has commenced to experiment by the introduction into India of new seed ; and the Government of Madras is moving in the same direction. It has been noticed that fields sown with seed imported from the Mozambique coast have produced satisfactory results while neighbouring crops sown with Indian seed have been very poor. More experiments are needed ; in the absence of any certain estimate of the relative values of different races it is impossible to foretell what the results will be.

I. HENRY BURKILL.

II.—MISCELLANEOUS NOTES.

Mr. John Mahon, formerly a member of the gardening staff of the Royal Botanic Gardens, and late Forester under the British Central Africa Protectorate (*Kew Bulletin*, 1897, p. 240), has been appointed, on the recommendation of Kew, by the Secretary of State for Foreign Affairs, Assistant Curator of the Botanic Station, Entebbe, Uganda.

Mr. Alfred Evans, a member of the gardening staff of the Royal Botanic Gardens, has been appointed, on the recommendation of Kew, by the Secretary of State for the Colonies, Assistant Curator of the Botanic Station, Aburi, Gold Coast.

Mr. John Reader Jackson, A.L.S.—The retirement of one of the longest and best known members of the Kew staff must be recorded regretfully. The following sympathetic notice is taken from the *Pharmaceutical Journal* (October 12, 1901):—

"Mr. John Reader Jackson, A.L.S., who for the past forty-three years has been keeper of the Museums of Economic Botany, Royal Botanic Gardens, Kew, has now retired, on September 30, a well-known authority on economic botany being thus removed from official life. During his long period of service the Kew Museums have increased largely in usefulness and popularity. The splendid nucleus formed by the late Sir William Hooker in 1842 has been considerably augmented by products from each successive International Exhibition since its date, the last exhibition at Paris affording an immense addition to the unrivalled collections already stored at Kew. The museums are especially rich in the products of our Indian Empire, owing to the transference to Kew in 1879 of the whole of the vegetable products contained in the old Indian Museum. Mr. Jackson joined the Kew staff simultaneously with Professor D. Oliver, F.R.S., who retired from the position of Keeper of the Herbarium in 1890. During Mr. Jackson's period of service three directors and four curators of the gardens have held office. To those who have had occasion to consult Mr. Jackson officially he will long be remembered for his extreme courtesy and geniality. We understand that he has removed from Kew to South Devon, and it is hoped that he will continue to add to the numerous and instructive articles on economic botany which he has contributed to various publications. Mr. Jackson is succeeded by Mr. J. Masters Hillier, who has been assistant to Mr. Jackson for twenty-two years, and the vacancy caused by Mr. Hillier's promotion has been filled by the appointment of Mr. J. H. Holland, who recently retired from the service of the Southern Nigeria Protectorate, where he was Curator of the Botanic Station at Old Calabar."

Dr. Emil Bretschneider.—The death of this eminent Russian sinologist and botanist has already been mentioned in *Hooker's Icones Plantarum*, in the letterpress to plate 2708 (*Bretschneidera sinensis*, Hemsl.); but it is only since then that we have found some particulars of the earlier part of his active career. He was born at Riga in 1833, and died at St. Petersburg on May 12, 1901. After finishing his medical studies he was physician to the Russian Embassy at Teheran from 1862–65, when he went in the same capacity to Peking, where he remained until he was pensioned in 1884. Dr. Bretschneider's correspondence with Kew began about the year 1880, and he sent dried plants from time to time, including a good set of his herbarium from the mountains near Peking. The extent of this collection may be estimated from the frequency with which his name occurs in the *Index Floræ Sinensis*. But Dr. Bretschneider was more a man of letters and linguist than a practical botanist, and his researches embraced the botany, geography, archæology, &c., of China. The results were mostly published in English. Among his works specially

interesting to botanists and pharmacologists we may name: *On the Study and Value of Chinese Botanical Works*, 1870; *Early European Researches into the Flora of China*, 1881; *Botanicon Sinicum*, 1882; and *History of European Botanical Discoveries in China*, 1898. The last is a monumental, large octavo, work of 1,167 pages, with a map of China in four sheets—the best extant. This "History" is of the greatest value to botanists and horticulturists alike, as it contains very full particulars of collectors and their journeys, collections, living and dried, as well as of descriptions and illustrations, with place of publication. An interesting letter from Dr. Bretschneider relating to this publication appeared in the *Bulletin* for 1898, pp. 313–317.

Botanical Magazine for September.—*Epidendrum osmanthum* is a handsome species, with fragrant flowers which last about two months. The Kew plant was purchased from Messrs. Sander & Co., who introduced the species from Brazil. The exceedingly pretty *Iris Tauri*, bulbs of which were received from Mr. Siehe, of Mersina, is a native of alpine pastures in the Eastern Taurus, growing at elevations of 4,500 to 6,500 feet. It is allied to *I. stenophylla*, figured on plate 7734. *Oxalis dispar* is a new species from British Guiana, closely resembling *O. Laureolæ* and *O. Noronhæ*. Its flowers are golden yellow, and about an inch across. This plant also was procured from Messrs. Sander & Co. *Impatiens Thomsoni*, the commonest sub-alpine species of the genus in the Western Himalaya, was raised from seeds received from J. F. Duthie, Esq., B.A., F.L.S., in 1900. It is described as a very attractive plant, from the abundance of its rose-coloured flowers amongst the deep green foliage, followed by the red, drooping pods. *Arctotis Gumbletoni*, a beautiful new species from Namaqualand, was grown in the garden of W. E. Gumbleton, Esq., of Belgrove, Queenstown, Ireland. Its stout peduncles are from eight inches to a foot high, with flower-heads three inches in diameter.

Botanical Magazine for October.—*Exorrhiza wendlandiana* is a native of humid forests in the Fiji Islands, whence some living plants were sent to Kew in 1881 by the late Sir J. B. Thurston, K.C.M.G. The plant from which the drawing was made flowered in February of the current year. Its height to the top of the crown of large pinnatisect leaves is 24 feet. The supporting roots emitted from the base of the trunk are spinous. *Habenaria Lugardii* was recently discovered in the Botletle Valley, Ngamiland, by Major F. D. and Lieut. E. J. Lugard, who presented some tubers to Kew. It has two large orbicular leaves adpressed to the ground and racemes of numerous white flowers, of which the petals are divided to the base into two and the lip into three long slender segments. The very slender spur is five to six inches long. *Cineraria pentactina* is a climbing plant, having small semi-orbicular leaves and small yellow capitula. It has been

grown at Kew for many years, and its native country is believed to be South Africa. *Calorhabdos cauloptera* is a Chinese Scrophulariaceous herb with ovate-lanceolate leaves and terminal spike-like racemes of small red-purple flowers. Seeds of this plant were received from Dr. Henry in 1896. *Calorhabdos* is a small genus closely allied to *Veronica*, differing, among other characters, in having all the leaves alternate. *Rubus palmatus*, a native of Japan and China, is a climbing shrub with five- or six-lobed sharply-toothed leaves and white flowers, the petals of which are elliptic—an infrequent occurrence in the genus. The drawing was made from a plant obtained from Messrs. James Veitch & Sons in 1899.

Botanical Magazine for November.—*Musa oleracea*, from New Caledonia, is the only known species having an underground tuber, by which the plant may be propagated in the same way as the potato. The tubers are full of starch, and when cooked in various ways are used as food by the natives of New Caledonia. The introduction of this plant to Kew is due to Mr. W. Soutter, Superintendent of the Gardens of the Brisbane Acclimatization Society. *Senecio magnificus* is a tall, stout glabrous undershrub, with usually oblong-lanceolate toothed leaves and moderately large golden-yellow flower-heads. It is a mountain plant of Victoria and South Australia. Seeds were received from J. H. Maiden, Esq., F.L.S., Director of the Botanic Garden, Sydney, in 1899, and plants raised from them flowered in the Temperate House in October, 1900. *Liparis tricallosa* is a terrestrial orchid from the Malay Peninsula and the Sulu Archipelago. First discovered by Mr. F. W. Burbidge, it was introduced into cultivation by Mr. W. Bull, of Chelsea, in 1879. The specimen figured was presented to Kew, when in full flower, by the Right Honourable Joseph Chamberlain in June, 1900. *Trevoria Chloris* was discovered by Mr. F. C. Lehmann in moist woods on the western slope of the Andes of Colombia at elevations of 4,800 to 5,500 feet. The genus, which is allied to *Coryanthes*, is named in compliment to Sir Trevor Lawrence, Bart., who communicated the specimen from which the drawing was prepared. *Syringa oblata*, a native of North China, is very closely allied to *S. vulgaris*, and is probably, Professor Sargent says, only a geographical variety of that species. The Kew plant, which was obtained from Mr. Lemoine, of Nancy, flowered in the Temperate House in April of the present year.

Work at Jodrell Laboratory in 1901:—

Boodle, L. A.—Comparative Anatomy of *Hymenophyllaceae*, *Schizæaceæ*, and *Gleicheniaceae*, continued. Part 2. Anatomy of *Schizæaceæ* (Ann. Bot., Vol. XV., June, 1901). Part 3. Anatomy of *Gleicheniaceae*. (Ann. Bot., Vol. XV., December, 1901.)

On an anomalous leaf of *Anemia hirsuta*. (Ann. Bot. Vol. XV., December, 1901.)

Brown, H. T., and Escombe, F.—Assimilation of Carbon in Green Plants.

Butler, E. J.—Biology of *Pythium*.

Fritsch, F. E.—Systematic Position of *Plagiopteron*.
Anatomy of *Elaeocarpus*.
Algae of the Royal Botanic Gardens.

Hill, T. G.—Anatomy of Stem of *Dalbergia paniculata*. (Ann. Bot., Vol. XV., March, 1901.)

Massee, G.—Life-History of *Macrosporium Tomato*.
Sclerotia on Seeds of *Conium maculatum*.

Massee, G., and Salmon, E.—Researches on Coprophilous Fungi. (Ann. Bot., Vol. XV., June, 1901.)

Pearson, H. H. W.—Researches on Fibre-plants.

Scott, D. H.—Structure and Affinities of Fossil Plants from Palaeozoic Rocks. Part 4. On the Seed-like Fructification of *Lepidocarpon*, a genus of Lycopodiaceous Cones from the Carboniferous Formation. (Phil. Trans. B., Vol. 194, 1901.)
Primary Structure of certain Palaeozoic Stems with the *Dadoxylon* Type of Wood (communicated to Royal Society of Edinburgh).
On a primitive Type of Structure in *Calamites*. (Ann. Bot., Vol. XV., December, 1901.)

Worsdell, W. C.—Contributions to Comparative Anatomy of *Cycadaceae*. (Trans. Linn. Soc., 2nd Ser. Bot., Vol. VI., 1901.)
The Morphology of the 'Flowers' of *Cephalotaxus*. (Ann. Bot., Vol. XV., December, 1901.)
Vascular Structure of the 'Flowers' of the *Gnetaceae*. (Ann. Bot., Vol. XV., December, 1901.)

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